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Water Pollution Series No. 66

A COMPREHENSIVE PROGRAM FOR WATER POLLUTION CONTROL

for the

LAKE SUPERIOR DRAINAGE BASIN

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66 Comprehensive water pollution control program for Lake Superior Drainage Basin, prepared in cooperation with State water pollution control agencies of Mich. Minn. & Wisc. 1954. [pub 1955] [Pub 367]

A COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM

for the

LAKE SUPERIOR DRAINAGE BASIN

Prepared in Cooperation with the State Water Pollution Control Agencies

of

MICHIGAN, MINNESOTA and WISCONSIN

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
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II

FOREWORD

Our country's development over the past 50 years has been marked by tremendous progress in many fields. It has made possible great gains in the health, comfort, and well-being of the people. But it has not been without cost. Part of the cost has been the damage to the Nation's water resources that has resulted from wastes discharged to the streams by our growing cities and industries. All water uses have been affected—public water supplies, recreation, agriculture, industry, fish and aquatic life.

In enacting the Federal Water Pollution Control Act in 1948, the Congress declared that "water pollution has become a matter of grave concern in many areas and its damaging effects on the public health and national resources are a matter of definite Federal concern as a menace to national welfare. Abatement must be undertaken in order to control it."

The Public Health Service, as part of its responsibilities under this Act, is required to prepare or adopt, in cooperation with other Federal agencies, State and interstate water pollution control agencies, municipalities and industries, comprehensive programs for the abatement of pollution.

This report describes the comprehensive water pollution control program for the Lake Superior Drainage Basin prepared in cooperation with the Michigan Water Resources Commission, the Minnesota State Department of Health and the Wisconsin Committee on Water Pollution. The program gives full consideration to the several present uses and to the reasonably anticipated future uses of the waters of this basin. It has been designed to provide an equitable balance in the pollution control requirements for various private and public groups concerned.

I am pleased, therefore, in my capacity as Surgeon General of the Public Health Service, to adopt this program as a comprehensive program which fully meets the requirements of the Federal Water Pollution Control Act.

This program is based on beneficial water uses and related conditions that prevailed on January 1, 1954. Comprehensive programs for pollution control must necessarily be flexible. They must allow for growth, development, and changing conditions. Any significant changes affecting water quality, such as stream flow, water use, industrial development, population, etc., may require changes in the pollution control program.

Obviously the mere adoption of this program will not, in itself, reduce pollution or improve the usefulness of the waters in this basin. It does provide to the citizens of the area and to the city officials and industrial leaders, farmers, fishermen, conservationists, and others an objective plan based on good engineering practice and reflecting sound economics. It is a plan which the public can support, and must support, if progress is to be made in the abatement of pollution.

Certain additional considerations beyond the mere acceptance of a plan are essential to its successful execution. The citizens of the areas affected must see that sufficient resources are provided to the State water pollution control agencies concerned to enable them to make the technical investigations to aid those responsible for constructing pollution abatement works.

We must recognize, too, that in order to be fully effective, the plans and programs of one State must be geared closely to those of adjoining States, since State boundaries are no barrier to pollution traveling in interstate streams. Above all, no program of this nature can progress beyond the report stage if its meaning and purpose are not made clear and understandable to the citizens of the area. In the final analysis, they are the ones who will pay, directly or indirectly, for the pollution abatement works that are needed.

It is my hope that this program for the Lake Superior Drainage Basin will be carried through to completion so that the area may enjoy all the benefits that clean water can provide, in health and recreational opportunities for the people and in sound growth of industry and agriculture.

Leonard A. Scheele

Leonard A. Scheele
Surgeon General

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

This report, prepared in cooperation with the water pollution control agencies of Michigan, Minnesota, and Wisconsin, sets forth a water pollution control program for the Lake Superior Drainage Basin. This program, which is based on data available as of January 1, 1954, was developed after a thorough consideration of the existing and potential uses of the water resources in the basin; the pollution entering the streams and lakes, and the resulting damages; the benefits which may result from pollution prevention and abatement; and the prevention measures now in effect as well as those which are needed.

Agencies which cooperated in the preparation of this report include the Michigan Water Resources Commission, Minnesota Water Pollution Control Commission, and the Wisconsin Committee on Water Pollution. Likewise, acknowledgment is made to the Corps of Engineers, Department of the Army; Soil Conservation Service and Forest Service, Department of Agriculture; Bureau of Census, Department of Commerce; Bureau of Mines, Fish and Wildlife Service, and Geological Survey, Department of Interior; and the Federal Power Commission, for their review of the report and for the information gleaned from their published reports.

COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM
for the
LAKE SUPERIOR DRAINAGE BASIN

General Characteristics and Economic Development

The Lake Superior Drainage Basin, as considered in this document, consists of the watershed areas of the streams and rivers draining into Lake Superior from the United States. The land area of the basin is approximately 16,860 square miles of which 46 percent is in Michigan, 36 percent in Minnesota and the remaining 18 percent in Wisconsin. The principal tributary rivers are the St. Louis, Montreal, Bad, Bois Brule, Carp and Ontonagon.

The basin has a rough topography with the land rising steeply from an elevation of 600 feet above sea level at the lake shore to altitudes of about 1,200 feet near the shore and 1,800 to 1,900 feet farther inland to the northwest in Minnesota. The area along the southern shore in Wisconsin and Michigan rises less abruptly, but to about the same height as in Minnesota. Most of the streams have steep gradients ranging up to 25 feet per mile.

The streams of the basin have reasonably uniform flows with lowest flows occurring in late fall and early winter. The most significant characteristic of the streams, from a pollutional standpoint, is the prolonged ice cover of about five months each year when there is little opportunity to replenish depleted dissolved oxygen by reaeration.

A modified marine climate occurs near the lake shore and particularly in the peninsular areas while farther inland the climate is continental. Monthly mean temperatures for the basin as a whole range from 10° F. to 63° F. with extreme temperatures ranging from a low of -47° F. to a high of 106° F. About 60 percent of the annual 30 inches of precipitation falls during the warm season, and snowfall varies from 55 inches to 376 inches in different parts of the basin. The growing season, which varies from 80 days in some parts of the basin to 130 in other areas, also reflects the wide climatic range produced by the two distinct types of climate found in the basin.

The basin's lakes, streams and scenic areas furnish excellent hunting, fishing and vacationing facilities, the use of which provides considerable income for the area. Commercial fisheries operating in Lake Superior bring in several million pounds of fish each year with almost 18 million pounds, valued at more than two million dollars, being caught in 1949.

The outstanding industries in the basin are the mining of iron ore and copper and the beneficiation of iron ore. Lumbering and paper manufacture are also of considerable importance while agricultural activity is very minor. Navigation is comparatively extensive and most of the iron ore that is produced in the three basin States moves through the basin's ports on its way to the mills. The total freight tonnage moving through the St. Mary's River amounted to over 128 million tons in 1953, with iron ore being the principal outgoing freight and coal, limestone, and petroleum products the principal imports.

The 1950 population of the basin was approximately 416,000 with 48 percent of the people living in Minnesota, 33 percent in Michigan and 19 percent in Wisconsin. Over half of the basin's people live in the 12 cities with populations of 5,000 or over, and one-third of the basin's population is concentrated in the Duluth-Superior area.

Water Use and Water Quality Objectives

The basin's waters are used for municipal, domestic and industrial supplies; fish and wildlife propagation; recreation; water power; navigation; and disposal of wastes.

Approximately 185,000 people, 45 percent of the basin's population, are served by municipal water supplies using surface water as a source, and a number of households, resorts, camps and others also depend upon surface water for their domestic supply. Most of the 17 municipalities that use surface water get their supply from Lake Superior, although other lakes and some of the rivers are also used as sources. The quality of finished water for municipal supply depends, to a considerable degree, upon the quality of the raw water used. The quality of the water used for individual private domestic supplies is, in general, the quality found at the

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source, as such supplies seldom receive treatment before use. Therefore, source water quality objectives are among the factors considered when determining the treatment requirements for pollution sources upstream from such supplies. In determining the suitability of water sources for municipal and domestic supplies, State health and water pollution control officials used Public Health Bulletin 296, "Manual of Recommended Water Sanitation Practice," and comparable State manuals as guides.

The larger industries of the basin also use surface waters as their source of supply. Water quality requirements for these industrial supplies vary, and no specific criteria can be adopted as each case must be considered separately in light of the specific needs of the industry under consideration. Of general concern, however, are the organic and biological constituents, toxic and taste- and odor-producing substances, and properties of corrosion, encrustation and slime formation.

The streams and lakes receive heavy recreational use, including sports fishing, swimming, camping and boating. There are numerous recreation developments, swimming areas, and National and State parks in the basin where camping, swimming, boating, and other recreational facilities are available. Quality objectives for the bacteriological quality of bathing places recommended by the Joint Committee on Bathing Places (Joint study of the American Public Health Association and conference of State Sanitary Engineers, covered in a report entitled "Recommended Practice for Design, Equipment, and Operation of Swimming Pools and Other Public Bathing Places," 1949), together with sanitary surveys, and comparable State criteria are employed in the administration of the basin's pollution control programs as related to bathing waters. Although quality objectives for water used for non-swimming recreation do not set forth as high a bacteriological criterion, the same basic fundamentals are used by the States in their program concerning those uses.

Sport and commercial fishing are very important uses of the waters which also serve as waterfowl refuges as well as general wildlife habitats. The general criteria advocated by the U. S. Fish and Wildlife Service calling for a balanced aquatic habitat and limiting concentrations of pollutional substances are used by authorities in this basin for fishing waters.

Ample flow, favorable river gradients, and the topography of the surrounding land make the streams of this basin very conducive to the development of water power, and there are 21 hydroelectric projects located within the basin. Navigation is confined to the waters of Lake Superior—the waterway over which most of the Nation's iron ore is moved to market. The basin's waters also serve as final outlets for the wastes of its communities and industries.

Sources and Effect of Pollution

There are 80 sewered communities and 196 separate industrial waste outlets in the basin which discharge to the watercourses a pollution load that has a combined population equivalent of more than 650,000.

Eighty percent of the basin's population reside in the communities that have sewerage systems, and over 312,000 of them are served by the municipal sewers. Two cities are discharging untreated sewage with a population equivalent of 64,000, while the other 78 communities are discharging an undetermined amount of treated and untreated sewage to the basin's waters.

Industrial organic wastes with a combined population equivalent of about 590,000 are being discharged through separate outlets by 13 industries, three of which account for 585,900 of this amount. Inorganic wastes are being discharged by 177 industries, most of which are mines and ore beneficiation plants.

The 29 municipalities which do not provide treatment for their wastes have a sewered population of 117,520, which is approximately 40 percent of the total sewered population in the basin. Eleven of the 51 existing municipal sewage treatment plants are considered to have inadequate capacity to handle their present load which totals about 112,000, while seven plants are not being operated satisfactorily. Ninety-three of the industries provide some degree of treatment for their wastes, but nine of these do not have adequate capacity to handle the present waste load.

Pollution has damaged water uses in certain areas of the basin, and most of this damage has been the result of depleted dissolved oxygen or high coliform bacterial counts in the waters. In the mining area of the basin, the damages have, in general, been due to the turbidity caused by the oxidation of the iron in the mine wastes and deposition of mine waste solids on stream beds, although the underground water source of Ironwood, Michigan, was damaged by mine wastes which increased the hardness and chloride content of the water. Fishing and recreational water uses have been most commonly damaged by pollution as depleted oxygen, high bacterial counts, excessive turbidities and solids deposition all affect these uses.

Several instances of fish kills and of odors in fish caught in the Pilgrim River have been reported. High coliform bacterial counts of over 240,000 per 100 cubic centimeters have been obtained in the Montreal River and have been attributed to the municipal wastes being discharged into this river. The State of Michigan placed the portion of this river beginning at Ironwood and extending 15 miles below that city on the 1950 list of waters which were unsafe for recreation, swimming, and allied purposes.

Untreated municipal wastes have caused serious pollution in several localized areas, and the waters were listed as unsafe recreational waters by Michigan in 1948 and 1949. These waters were Lake Superior along the Marquette frontage, Portage Lake along the Houghton-Hancock frontage, the Tahquamenon River from Newberry to 10 miles below that city, and the Ontonagon River through Ontonagon, Michigan. Contamination of the lake beach by untreated sewage from L'Anse, Michigan, is reported to have curtailed its use.

According to the 1948 joint Report of the Minnesota State Board of Health and the Wisconsin Committee on Water Pollution: "In the area below Fond du Lac (St. Louis River), the effects of the pollution from upstream and of that contributed by Duluth and Superior are most evident during the ice coverage period of the winter. Because of the large surface area exposed for reaeration and because of the dilution factor, the river shows some improvement in its flow through the bay area in the open-water season. However, bottom samples showed the presence of sludge deposits, and biological examinations indicated high pollution throughout most of the bay area."

This report also states: "The recreational use of the river from Cloquet downstream is definitely curtailed by existing conditions. A public health hazard exists as a result of bacterial contamination from untreated domestic sewage. The Minnesota Department of Conservation has pointed out that this section of the river is unsuited for fish or fish culture. Although that Department did not investigate the harbor area, the low oxygen conditions found under ice coverage and the sludge deposits observed would indicate that this section also is not favorable for fishing or fish propagation."

Progress in Pollution Abatement

The water pollution control agencies of the States are actively working on the pollution problem and are using existing authority in a judicious and effective manner. They work cooperatively with municipalities and industries in solving pollution problems and enforcing existing statutes. Their pollution control programs and the cooperation of municipalities with these programs have resulted in sewage treatment being provided by 31 of the basin's 50 sewered communities. The population served by the existing sewage treatment plants consists of 60 percent of the basin's total sewered population. Ninety-three of the 130 industries that have separate outlets to the basin's streams have facilities providing some degree of treatment of their wastes.

The water pollution control laws of the States in this basin are adequate to abate existing pollution and to prevent or control new or increased sources of pollution, and their activities are directed toward this end. The state water pollution control efforts have been quite successful, but in order for the State agencies to continue their effective and active programs, they must be furnished with adequate appropriations to attract and hold sufficient qualified personnel to carry on their activities.

Pollution abatement and control is continuing to advance in this basin, and at the present time, six municipalities and six industries are actively making plans for the waste treatment improvements that they need; seven municipalities and one industry have plans for the needed improvements approved and ready for construction; while three other municipalities and five industries have their needed improvements under construction.

Pollution Prevention Measures Required

Excellent work has been done on the control of pollution within recent years, but to adquately control or prevent all damaging pollution there are still a number of projects that must be constructed. Analysis of the available data which show stream characteristics, the amount of wastes discharged to the watercourses, present water quality in the streams, and existing water uses in relation to generally accepted water quality objectives has enabled the determination of treatment requirements for the major sources of pollution in this basin. These requirements consist of 17 new sewage treatment plants, one of which is needed to replace an existing plant. The other 16 new plants are needed for communities that are now discharging untreated sewage from a total contributing population of 94,000 people. Enlargements or additions are needed at nine existing sewage treatment plants now serving 111,000 people. At 15 municipalities, no conclusions as to the extent of treatment needed have been reached.

It is estimated that the construction of all of the basin's needed municipal sewage treatment facilities which are definitely known to be needed will cost approximately $5,000,000. This cost estimate does not include such items as sewers, interceptors, right-of-way, etc., which will vary with each project and with local conditions.

There are 11 new industrial waste treatment works needed at industries that do not now have treatment facilities, and one existing plant needs to be abandoned and the waste discharged to the municipal sewer if adequate treatment is to be obtained. In addition, 11 existing industrial waste treatment plants require enlargement or additions in order to reduce to an acceptable level the industrial pollution load they now discharge to streams of the basin. Many of these needed facilities will be small, but others will, no doubt, involve considerable construction and expense. At 99 industries no conclusions as to the extent of treatment needed has been reached. No satisfactory estimate of the cost of the industrial waste treatment facilities is possible since the nature of the wastes and possible in-plant improvements will vary widely, even within identical industrial groups.

The determination of the total pollution load from all municipalities and industries would require securing additional detailed data, which is not warranted since the data now available are sufficient for the continuation of the comprehensive program and the elimination of many of the pollutional problems that now exist.

Water Pollution Control Program

The needed corrective measures discussed herein and listed below are based upon studies and investigations made by the responsible water pollution control agencies in the States concerned, and are part of the pollution abatement program now being carried out by the agencies. The pollution prevention and control measures recommended are intended to restore, preserve, and protect all reasonable water uses including those now existing and those which may materialize in the immediate foreseeable future. These remedial measures were arrived at only after a thorough consideration of all water uses in the basin and are considered to be reasonable and adequate.

The corrective measures listed below are flexible and are intended to reflect the needs for the present situation as it now exists; however, changes in stream characteristics, pollutional load, or water uses, may require revisions in the indicated required treatment at some future date. The program does not include 11 municipalities and industries where conclusions as to the extent of treatment needed had not been reached.

The essential elements of the program as developed in cooperation with the States concerned consist of the following:

1. Provide the following improvements:

Name and Location	Improvements Needed	Remarks
MICHIGAN		
Bergland	New treatment plant	Abatement by 6/1/55 ordered

Name and Location	Improvement Needed	Remarks
MICHIGAN (Contd.)		
Ironwood	New treatment plant	Abatement by 12/31/53 ordered Enforcement pending
Grandview Hospital	Replacement of existing treatment plant	Under construction
Ishpeming	New treatment plant	Abatement by 6/1/55 ordered Plans approved
L'Anse	New treatment plant	Plans approved Abatement by 6/1/55 ordered
Munising	New treatment plant	Plans approved Abatement by 6/1/54 ordered
Munising Paper Co.	Additions to existing treatment plant	Active planning
Ontonagon	New treatment plant	Active planning Abatement by 6/1/55 ordered
Wakefield	New treatment plant	Abatement by 6/1/54 ordered
MINNESOTA		
Biwabik Canton Mine	Additions to existing treatment plant	Under construction
Higgins No. 1 Mine	Additions to existing treatment plant	Under construction
Mary Ellen Mine	Additions to existing treatment plant	Active planning
Mary Ellen Concentrating Plant	Additions to existing treatment plant	Active planning
Ruby Mine	Additions to existing treatment plant	Under construction
Carlton	New treatment plant	Plans approved
Chisholm	New treatment plant	Under construction
Cloquet	New treatment plant	Active planning
Northwest Paper Co.	Enlargement of existing treatment plant	Active planning
Wood Conversion Co.	Enlargement of existing treatment plant	Active planning

Name and Location	Improvements Needed	Remarks
MINNESOTA (Contd.)		
Duluth	Enlargement of existing treatment plant	Active planning
American Steel & Wire Co.	New treatment plant	Plans approved
Interlake Iron Corporation	New treatment plant	
Esko	Enlargement of existing treatment plant	Active planning
Eveleth	Enlargement of existing treatment plant	
Floodwood	New treatment plant	Plans approved
Floodwood Coop. Cry. Assn.	New treatment plant	
Fraser	Additions to existing treatment plant	
Gilbert	Enlargement of existing treatment plant	
Kinney	Additions to existing treatment plant	
McKinley	Additions to existing treatment plant	
Meadowlands	Additions to existing treatment plant	
Mesaba Twp.		
Knox Mine	Enlargement of existing treatment plant	Active planning
Mountain Iron	Additions to existing treatment plant	Under construction
Two Harbors	New treatment plant	
Wrenshall		
International Refineries	Addition to existing treatment plant	Under construction
WISCONSIN		
Bayfield	New treatment plant	Active planning
Bayfield Fruit Cannery	Connect to existing municipal sewers	
Benoit		
Benoit Coop. Cry.	New treatment plant	

Name and Location	Improvements Needed	Remarks
WISCONSIN (Contd.)		
Cornucopia		
Cornucopia Cheese Fct.	New treatment plant	
Iron River		
Fuhrman Cheese Fct.	New treatment plant	
Fuhrman Sausage Fct.	New treatment plant	
Marengo		
Marengo Coop. Dairy Assn.	New treatment plant	
Mason		
Mason Milk Products	New treatment plant	
Mellen	New treatment plant	Plans approved
Moquah		
Moquah Cheese Fct.	New treatment plant	
Poplar		
Poplar Canning Co.	Additions to existing treatment plant	
Saxon		
Belmonte Cheese Fct.	New treatment plant	
Superior	New treatment plant	Plans approved
Washburn	New treatment plant	Active planning

2. Operate all existing and future waste treatment works at a uniformly efficient and high level in order to obtain maximum benefits from these facilities and permit their most effective utilization.

3. Continue the policy of requiring adequate treatment of wastes from both new sources and expanded use of existing facilities in order to preclude new pollution problems.

PHYSICAL DESCRIPTION

The Lake Superior Drainage Basin as considered in this document consists of the watershed areas of the streams and rivers that drain into Lake Superior from the United States. The total land area in the basin is 16,860 square miles with 46 percent in Michigan, 36 percent in Minnesota and the remaining 18 percent in Wisconsin. Lake Superior is the largest body of fresh water in the world and is the deepest of the five Great Lakes. Its surface elevation varies from 600 to 604 feet above mean sea level, while its bottom at the deepest point is 702 feet below mean sea level, giving the lake a maximum recorded depth of 1,302 feet.

The principal river of the basin is the St. Louis which has a drainage area of about 3,700 square miles and is an interstate stream that forms part of the Minnesota-Wisconsin boundary. The Montreal River, which forms part of the boundary between Wisconsin and Michigan, is one of the smallest of the principal streams in the basin. Other principal rivers are the Bois Brule and Bad Rivers in Wisconsin and the Ontonagon River in Michigan.

The topography of the basin, in general, is rough, with the land rising steeply from the lake level of about 600 feet above mean sea level to altitudes of about 1,200 feet near the shore, and 1,800 to 1,900 feet above mean sea level farther inland along the northwest shore of the lake in Minnesota. The Wisconsin-Michigan area along the southern shore rises less abruptly, but the height of the escarpment is about the same as in Minnesota.

The soil is a mixture of sandy loam and red clay that is not particularly well adapted for farming. In addition to the low soil fertility, the short growing season is another factor that adversely affects agricultural activities. Much of the basin is heavily forested and the timber provides a basis for a profitable lumbering industry.

The climate of the basin is continental in the interior, while a modified marine climate is found near the lake shore and particularly in the peninsular areas. These two distinct types of climate are reflected in the temperatures, precipitation, and growing seasons. Extreme temperatures range from -47° F. to 106° F., while the basin's average temperatures range from 8° F. to 12° F. for January, and 60° F. to 66° F. for July. The average annual precipitation is 28 to 32 inches with 16 to 19 inches falling during the warm season. Snowfall varies from 55 inches to 276 inches in different portions of the basin, and the growing season, which also reflects the wide climate range, varies from 80 to 130 days in different portions of the basin.

Run-off in this basin averages about one-third of the annual precipitation, and the heavily forested areas and soil carpet retard much of the run-off providing fairly steady stream flows even during drought periods. Most of the streams have steep gradients, ranging from 4.6 to 25 feet per mile, which results in rapid flows and good reaeration characteristics.

The streams of the basin have reasonably uniform flows with the low flows occurring in late fall or early winter. The mean monthly flows, in general, amount to about 10 percent of the average annual flow, although they occasionally drop to about 5 percent of the average annual flow.

From a pollutional standpoint, a significant characteristic of the basin's streams is the long period of ice cover during the winter, extending over approximately five months. When the streams are covered with ice, there is little opportunity for reaeration of the water and consequently it is difficult for the stream to naturally overcome the effects of pollution. During warm weather, the amount of oxygen that stream water can absorb is reduced and bacterial growth is accelerated. As a result, critical low flows become an important factor, either when the streams are covered with ice or when the temperatures are high, in determining the waste treatment necessary to provide water of suitable quality for the legitimate water uses.

ECONOMIC DEVELOPMENT

Changes in the basin's population have, in general, closely followed changes in the industrial activity in the area. The basin had a steady increase in population during the development of the lumbering and mining industries, but, now that these industries have exhausted a large portion of their readily available raw materials and have started to decline, the basin's population is experiencing a corresponding reduction. The total 1950 estimated population for the basin was about 416,000, a net loss of about 5 percent over the 1940 census.

Forty-eight percent of the people live in Minnesota, 33 percent in Michigan and the remaining 19 percent in Wisconsin. Over half of the basin's population is centered in 12 municipalities, five of which have a population of 5,000 to 10,000, and seven with populations in excess of 10,000. The latter group includes Ashland, Superior, Marquette, Duluth, Virginia, Kibbing and Ironwood, which have a total combined population of 207,000. Duluth, with a 1950 population of over 104,000, has three times the population of Superior, the next largest city. Most of the 12 municipalities with populations over 5,000 suffered population decreases during the 1940-50 period.

Over 250,000 people live in the Duluth-Superior metropolitan area, the most densely populated region in the basin. With the exception of strictly localized municipal population centers, the basin as a whole is very sparsely settled with population densities as low as five persons per square mile in some places.

The average effective buying income for the basin was approximately $1,210 per person in 1950, slightly less than the national average of $1,311 for the same year.

The principal industrial activities of the basin include mining, lumbering, fishing, quarrying, navigation, and during appropriate seasons, catering to the hunting, fishing and tourist trade.

The first modern copper mine was opened near Copper Harbor, Michigan, about 1844, the same year that iron ore was discovered at Negaunee, Michigan. Copper mining is still carried out in the basin, but not to the same extent as formerly. At one time, some silver was also produced in the basin. The Vermillion Iron Range of Minnesota was discovered in 1890 and the Mesabi Iron Range in 1866. The first iron ore was shipped from the Vermillion Range in 1884 and from the Mesabi Range in 1892. Iron mining has flourished since that time and the basin's mines produced a total of about 76,000,000 tons of iron ore in 1951. The bulk of this (60,500,000 tons) was taken from the Minnesota portion of the basin, while Michigan mines produced 13,600,000 tons and Wisconsin mines 1,750,000 tons. The estimated value of the iron ore produced in 1951 was approximately $500,000,000 (value at mines). Much of the iron ore is processed before shipment, and at the present time there are 36 beneficiation plants in the Minnesota portion of the basin. Twenty-four of these plants use a wet beneficiation process and are, therefore, possible sources of liquid wastes. Additional plants for processing iron ore bearing rock (taconite) are under construction.

Lumbering began in the basin about 1878 near Baraga, Michigan, and during the period between 1891 to 1924 an estimated 7,700,000,000 board feet of lumber, valued at about $130 million, were shipped from Duluth Harbor. Heavy cutting and severe fires have reduced available timber to a point where lumbering has been greatly curtailed throughout the area. However, some lumbering is still carried out and pulp wood, cut chiefly from second growth, is of economic importance to the basin.

Fishing has always been an important source of revenue for all of the States bordering Lake Superior. In 1949, the total value of the fish catch in Lake Superior for Michigan, Wisconsin and Minnesota was $2,190,111, with the States ranking in the order given. Sports fishing is increasing, and with hunting and tourist trade, it has assumed an increasingly important place in the economy of the basin. Recreational use of the basin's waters is extensive, especially in the five national forests and the numerous State forests and parks.

Wisconsin, which is the only State to estimate the revenue from the tourist business in the basin, places a value on tourist business in the basin at $26,000,000 annually. While the other

States have not made specific estimates for this basin, the importance of this industry to the States as a whole is illustrated by the fact that the tourist business is ranked the second largest industry in Michigan and Minnesota and the fourth in Wisconsin. On a Statewide basis, this industry is valued by Michigan at $700,000,000, while the Statewide value of this industry in Wisconsin and Minnesota is $300,000,000 and $100,000,000, respectively.

Navigation, with its docks and shipping facilities, is one of the major industries of the basin. In 1953, there were 285 ore vessels operating in the Great Lakes with a total combined trip capacity of over 3,300,000 tons. Ore dock facilities in the Great Lakes' ports located in the basin consisted of 16 docks with a combined storage capacity of 1,334,150 tons. In addition to ore loading facilities, the ports of the basin are equipped to handle grain, petroleum products, coal and other freight. Duluth-Superior Harbor has become the world's largest ore shipping center and one of the nation's largest shipping centers. With an average 6,000 vessel arrivals per year, it is second only to New York City in shipping tonnage in the United States. The navigation season at Duluth-Superior Harbor averages approximately 233 days and extends from about April 2 to about December 10.

Industrial activities carried out in the basin include steel, cement, pulp and paper production, food canning, oil refining, chemical production and metal working.

Because of the short growing season, the extreme low temperatures, and the relatively poor soil in many parts of the basin, agriculture is not extensively practiced in the area.

USE OF WATER RESOURCES

Important uses of the basin's waters include: domestic and industrial supply, fishing, wildlife habitat, bathing and other recreation, development of hydroelectric power, navigation and disposal of waste. The primary use in some areas is industrial and domestic supply, but the predominant use throughout the basin is in connection with sport and commercial fishing, hunting and recreation. Navigation is also an important water use, but it is limited to Lake Superior and adjacent waters. In limited areas, there is some use for crop irrigation.

The ground water in the area is generally much harder than surface waters and where sources of surface supply are conveniently located and free of serious pollution, they have frequently been developed into municipal supplies. There are 17 municipal water supplies obtained from the surface waters in the basin. These supplies are principally from Lake Superior; however, other surface sources include Teal Lake, Presque Isle River, Lake Lavinia and Black River. A total of about 185,000 people are supplied by these surface water supplies. A large number of households, camps, and others also depend upon surface water for their individual domestic supply.

Source water quality objectives are among the factors considered in determining treatment requirements for pollution sources upstream of municipal and domestic supplies. In appraising the suitability of water sources for such supplies, State health and water works officials use Public Health Bulletin 296, "Manual of Recommended Water Sanitation Practice," and comparable State criteria as guides.

Ten industrial water supplies are obtained from surface sources, but the quantity used for cooling or process purposes, with or without treatment, is not known. Nearly all of the major industrial developments in the basin, with the exception of mining, have been in localities where large quantities of good water are available. Because of the diversity of uses, quality requirements for industrial supplies vary widely, and no general water criteria have been adopted as each case must be considered separately. Of general concern, however, are the organic and biological constituents, temperature, toxic substances and properties of corrosion, incrustation and slime formation of the available waters.

The lakes, streams and scenic areas within the basin provide sport fishing, hunting, swimming, skating, boating and several other forms of recreation. The lakes and larger streams contain northern and walleyed pike, bass, perch and pickerel, while the temperatures and dissolved oxygen content of the waters in the majority of the smaller streams are suitable for trout.

The waters of Lake Superior support a substantial commerical fishing industry. The average annual catch in the United States portion of Lake Superior has risen from a total of about 6,600,000 pounds in 1880 to 17,730,000 pounds in 1949, with a value of $2,190,111 in 1949. The annual lake trout catch has varied from 1,800,000 to 4,500,000 pounds, while the lake herring catch has risen steadily from about 380,000 pounds in 1880 to over 13,204,000 pounds in 1949. Whitefish, another important species, amounted to 1,283,700 pounds in 1949. Lake Superior ranked third among the Great Lakes, following Lake Erie and Lake Michigan in that order, in total pounds of fish caught during 1949.

Hunting is popular in the basin and while it is not a direct water use it depends, to a large extent, upon the game attracted to the area by the water available for its use and convenience. Hunting camps and lodges are generally located where an ample supply of good water is available for domestic use as well as for aesthetic enjoyment.

Water quality objectives for fishing waters vary with the type of aquatic life to be protected. The general objectives advocated by the U. S. Fish and Wildlife Service calling for a balanced aquatic life habitat and limiting concentrations of pollutional substances are usually used by authorities in this basin. Consequently, toxic and oxygen-consuming wastes and those which form sludge beds, silt, and other deposits which tend to blanket the stream bottom and destroy biological life so vital to the existence of fish are considered undesirable.

The waters of the basin are widely used throughout the year for recreational purposes by vacationists and others, while bathing, of lesser importance because of the low temperature of the water, is enjoyed during the warm season at the many beaches.

Contamination of bathing and recreational waters by sewage, especially that of recent origin, is objectionable as water for such use should be free from floating solids, sludge deposits, odors and discoloration. Quality objectives for the bacteriological quality of bathing waters as recommended by the Joint Committee on Bathing Places (Joint study by the American Public Health Association and Conference of State Sanitary Engineers, covered in a report entitled "Recommended Practice for Design, Equipment and Operation of Swimming Pools and Other Public Bathing Places," 1949), together with sanitary surveys and comparable State criteria, are employed in the administration of pollution control programs as related to bathing waters of this basin. Under the Joint Committee interpretation, various classifications of waters are defined as based on the number of coliform organisms per 100 milliliters of water. Other indices of quality, as enterococci, are receiving increasing attention; however, sanitary surveys are employed in pollution control programs as related to bathing waters. Although quality objectives for water used for non-swimming recreation do not set forth as high a bacteriological criterion, the same basic fundamentals are used by the States in their programs.

Ample flow, favorable river gradients, and the topography of the area make the streams of this basin especially well suited for the development of water power. The power needs of the mining and paper industries and others have led to the installation of power dams at several locations in the watershed. There are 12 hydroelectric developments in Michigan with an installed generating capacity totaling 45,370 kilowatts. These developments are located on the Montreal, Ontonagon, Sturgeon, Fall, Dead, Carp and Au Train Rivers. Three of the largest water power developments in Minnesota are located on the St. Louis River at Scanlon, Thompson and Fond du Lac. Two other dams located in Cloquet supply power for the wood products industries there and also supply a source of process water and ponds for floating logs. Other dams in the Minnesota portion of the basin are small and are used either for control of water levels or for limited power sources. There are four power dams in the Wisconsin portion of the basin, with two on the Iron River and one each on the White and Bad Rivers.

Navigation has been a significant factor in the development and growth of the basin. The streams and lakes were the main avenues of traffic for the early fur traders and settlers. Later, the waterways were used to move the basin's lumber and ore to market and this economical transportation was largely responsible for the full development of these resources. In 1953, the total tonnage leaving and entering Lake Superior through the St. Mary's River amounted to over 128 million tons. Freight traffic for the Duluth-Superior Harbor during the same year and which is included in the above figure brought in 5,000,000 tons of coal, 916,000 tons of stone and rock and 217,000 tons of gasoline and petroleum products and some cement, automobiles and manufactured iron and steel. Outgoing freight included 1,800,000 tons of wheat, 3,400,000 tons of crude oil and 64,000,000 tons of iron ore and some scrap iron, molasses, flaxseed, corn, barley and iron and steel products.

All of the above water uses are considered essential for the economy, health and welfare of the people of the basin, and protection of the water resources from pollution is necessary for the continued development of the area. Treatment of the wastes discharged to the watercourse will be necessary to achieve pertinent water quality objectives and to maintain the streams and lakes of the basin in a suitable condition for the indicated water uses.

POLLUTION DISCHARGED TO SURFACE WATER

There are four large sources of pollution in the basin for which the amount of pollution discharged to the watercourse has been determined. These are the City of Superior, Wisconsin, the two paper mills at Cloquet, Minnesota, and the paper mill at Munising, Michigan. There are other municipalities and industries that are discharging undesirable amounts of polluting wastes, particularly the food processing plants, the other paper mills and some of the municipalities located on small streams, but the strength and pollutional characteristics of the waste reaching the watercourse from such sources have not been precisely determined.

Over 80 percent of the basin's total 1950 population live in the 80 communities which have sewerage systems, and 312,775 of the residents of these communities are served by the municipal sewers. The sources of untreated, partially treated, and treated municipal wastes which are discharged into the surface waters of the basin are individually listed in the Appendices and summarized in Table A. The communities in the basin which have sewerage systems and which are, because of these systems, sources of municipal wastes include one city serving 100,000 people, one city serving 35,000, six serving 10,000 to 20,000, five serving 5,000 to 10,000, twenty-eight serving 1,000 to 5,000 and twenty-nine serving less than 1,000.

TABLE A
SEWERED MUNICIPALITIES*

Municipalities*	Number	Population Served by Sewerage System	Amount of Pollution Discharged to Watercourse (In terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	2	36,900	64,000
Having population data available (Data on pollution load to the watercourse incomplete or not available)	78 1/	275,875	Not applicable
TOTAL	80	312,775	XXX XXX

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers; and industrial wastes discharged into municipal sewerage systems.

**Population Equivalent (PE) is a method of expressing the amount of organic waste in terms of an equivalent number of persons. The Calculated Population Equivalent is based on 0.167 pounds of Biological Oxygen Demand per capita per day. This is a measure of the amount of oxygen resources of the receiving stream which will be utilized in the oxidation process. It is not in itself a measure of health hazard.

1/ Includes nine sources in which the population served is undetermined.

The activities of the State Departments of Health and State water pollution control agencies have resulted in 51 of the communities providing sewage treatment facilities for their wastes. However, the pollution control secured by some of these plants is not entirely satisfactory at present because some are not being operated satisfactorily, while others do not have adequate capacity or facilities to produce the degree of treatment now required by the water uses downstream. Because of age, or for some other reason, 11 of these plants no longer have adequate capacity to handle the loads imposed on them and cannot reduce the pollution characteristics of the waste to the extent needed. Operation at seven plants is not considered to be entirely satisfactory, and pollution is not reduced as much as it could be by the efficient use of existing facilities.

Twenty-nine municipalities, serving a combined population of 117,520, do not treat their wastes. The largest of these is Superior, Wisconsin, which is discharging a waste with a population equivalent of 60,000, although the population served by the sewers is 35,000, indicating that the Superior municipal sewers pick up a sizable industrial waste load. Eleven other cities with populations over 2,500 do not provide treatment for their wastes.

A summary of the industrial sources of pollution which discharge their wastes directly into the basin's watercourses is shown below. These sources are also shown in Table D, in the section discussing prevention measures in effect, where they are tabulated according to the type of industry and the treatment provided for their wastes.

TABLE B

SEPARATE INDUSTRIAL OUTLETS

Industries	Number	Amount of Pollution Discharged to Watercourse (In terms of equivalent number of people)
Producing organic wastes	13	592,750
Producing organic wastes	17	Not known
Producing inorganic wastes	177[1]	Not applicable
TOTAL	196[2]	

1/Includes eleven industries that also produce organic waste.

2/Total adjusted to correct for duplication noted in footnote 1/.

There are 196 industrial sources of pollution which do not discharge their wastes to a municipal sewerage system. Ninety-three of these are known to provide some degree of treatment for their waste and 52 are known to provide no treatment. Basic data on individual industrial sources of wastes are given in the Appendices. Thirty of the industries discharge oxygen-consuming organic wastes, and 177, the majority of which are iron mines and iron ore beneficiation plants, discharge inorganic wastes.

On the basis of population equivalent, the total known sewage and organic industrial waste load discharged to the basin's watercourses is equivalent to the wastes from over 650,000 people. This is 50 percent greater than the entire population of the basin, although it does not include the wastes from 78 municipalities and 17 industries for which specific data have not been reported.

DAMAGES TO WATER RESOURCES FROM POLLUTION

Many of the basin's streams and lakes are relatively free of pollutional damage as they do not receive polluting materials, while the amount of such material that others receive does not exceed their capacity for assimilation of such pollution consistent with the present water uses. However, excessive pollution has damaged water uses in certain areas of the basin and posed a threat to the public health in other areas. The amount of damage varies with the degree of pollution and depends upon the extent to which the major existing water uses have been affected or potential future water uses discouraged by the unsatisfactory water quality resulting from the pollution.

Water use damage results from bacterial pollution, deoxygenation by organic materials, toxicity, increased hardness, or the presence of solids, turbidity, color, odor, or taste-producing substances. Most of the damages that have occurred within the basin have been the result of depleted dissolved oxygen or high bacterial counts in the waters. In the mining areas, however, the damages have, in general, been caused by excessive turbidity and deposition of solids.

Mine wastes discharged into Siemen's Creek adversely affected the municipal ground water supply of Ironwood, Michigan, by increasing its hardness to about 900 parts per million and its chloride content to 1,100 parts per million. The city relocated its well field, but the mine waste pollution continued to threaten its supply and the State instigated action which led to the temporary diversion of the mine drainage to another watershed with provision for removal of solids and turbidity. Ironwood's water supply has now been protected from pollution, but the city is still discharging its own untreated sewage which is polluting the Montreal River and adversely affecting water users below.

In 1949, the Marquette City Health Officer expressed concern over the increase in coliform organisms in the city's raw water, which he attributed to the untreated wastes from that community. Objectionable tastes and odors were also reported experienced at intervals due to chemical wastes.

High coliform bacterial counts of over 240,000 per 100 cubic centimeters have been obtained in the Montreal River and have been attributed to the municipal wastes from Ironwood, Michigan, and Hurley, Wisconsin. These wastes caused serious pollution in this stream extending from within the corporate limits of the two municipalities to at least five miles below Ironwood. The State of Michigan placed this river on the 1950 list of waters which were unsafe for recreation, swimming, and allied purposes, beginning at Ironwood and extending for 15 miles below that city. Hurley, Wisconsin, completed a sewage treatment plant in 1953. Ironwood, Michigan, has failed to comply with an order issued by the State to provide treatment by December 31, 1953, and enforcement action is pending.

Untreated municipal wastes have caused serious pollution in several areas and the waters were listed as unsafe recreational waters by Michigan in 1948 and 1949. These waters included Lake Superior along the Marquette frontage, Portage Lake along the Houghton-Hancock frontage, the Tahquamenon River from Newberry to 10 miles below that city, and the Ontonagon River through Ontonagon, Michigan. Contamination of the lake beach by untreated sewage from L'Anse, Michigan, is reported to have curtailed its use.

The polluted condition of the St. Louis River from Cloquet, Minnesota, to the mouth curtails recreational use of the water, according to a 1948 report by the Minnesota Department of Health entitled "Report of the Follow-up Survey of the Pollution of the St. Louis River." According to this report, a public health hazard exists as a result of bacterial contamination from untreated domestic sewage and the Minnesota Department of Conservation considers this section of the river unsuited for fish or fish culture.

Oil pollution in the Duluth-Superior Harbor has been the cause of complaints received by State and Federal agencies. Unauthorized discharge of oil and oily water from vessels is suspected to be the source of this pollution, although this has never been definitely established.

The Munising Conservation Club registered a complaint in 1948 regarding pollution of the Anna River and Munising Bay by the city of Munising. The complaint alleged that pollution of this river and the bay by the city resulted in trout kills and also indicated that the paper mill, as well as the city, was an offender. The Michigan Water Resources Commission cited the paper

mill in 1948 for failure to control pollution and has ordered the city to provide treatment of sewage by June 1, 1954.

The loss incurred through reduction of property values along polluted waters should not be overlooked when pollution damages are being considered. The condition of the available water is an important factor when locating a home, camp or recreational development on or near waterfront property. There is little doubt that property values have declined due to pollution in the basin, especially along the streams and beaches that have had to be declared as unfit for recreational and swimming purposes.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

Water pollution in this basin has not been widespread, but there are some areas where correction of polluted conditions are necessary and desirable to restore the affected waters to their most useful condition. By abating existing pollution, the damaged water uses can be restored and, by preventing additional pollution, future water uses can be preserved. The existing sewage and waste treatment facilities now operating in the basin have been of great value in reducing the damage of the receiving waters to a minimum and in correcting some of the damage that had developed.

Pollution abatement activities are costly, but the cost is generally well justified considering the long-range benefits which accrue. The use of the surface waters for commercial and sports fishing and for recreation is of considerable benefit to the economy of the entire basin and pollution control to protect water quality for these uses is well worth while.

Preserving and improving the quality of surface water sources of public and industrial supplies is of specific benefit to the industry and municipality whose water supply is now being threatened or damaged. Monetary benefits will result from the production of safe potable water for domestic use and acceptable process water for industry at minimum treatment costs.

The benefits to be derived from the provision of clean water for recreational use in an area so well adapted to such activities are self-evident. The provision of adequate treatment of wastes is required in the interest of aesthetics as well as for the reduction of the threat of water-borne disease. Effective pollution prevention measures will improve the water quality and provide a safer environment for swimming, boating and fishing in those areas where bacterial pollution is now greater than is considered safe or desirable for these water uses.

Pollution control measures are necessary to assure continued and increased benefits from both commercial and sports fishing. Abatement of pollution will aid in promoting wider development of water uses, and prevention of future pollution will assure continued use. Wider development of the water resources for recreational use will attract additional revenues to the area from vacationists and sportsmen, but only if there are clean waters available for their enjoyment.

The availability of good quality water is a requisite to the development of many industries and a major factor in locating industrial plants. Thus, adequate pollution control programs which insure water of desired quality are of economic importance to the basin in maintaining existing industry and in attracting additional industry to the area.

POLLUTION PREVENTION MEASURES IN EFFECT

Over three-fourths of the total basin population live in the 80 municipalities that are served by sewerage systems. Fifty-one of these communities with a total combined sewered population of 195,000 have also provided sewage treatment facilities consisting of twenty-one primary treatment plants and thirty secondary sewage treatment plants.

TABLE C

EXISTING MUNICIPAL* TREATMENT FACILITIES

Degree of Treatment Provided	Number of Municipalities	Number of Plants	Population Served
Primary	21	21	142,040
Secondary	30 1/	30 1/	53,215
No Treatment	29		117,520

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers, and industrial wastes discharged into municipal sewerage systems.

1/Includes nine in which the population served is undetermined.

As shown in Table D, mining and its associated primary metals industry have the largest number of industrial establishments that are discharging wastes directly into the watercourses. Forty percent of these industries are providing treatment for the inorganic wastes which they produce. This treatment generally consists of sedimentation for the removal of suspended solids, and in many cases the industry reuses the clarified water for further processing. The food processing industry has the largest number of establishments that are discharging organic wastes. However, the paper industry is by far the most important organic waste producing industry from a pollution standpoint. All four of the paper mills have provided treatment facilities, and about half of the food processing plants are treating their wastes. A total of 93 industrial plants in the basin are now providing some type of treatment for their wastes. One of the food processing plants has provided treatment that is equivalent to secondary degree of sewage treatment. All of the other industries have provided primary or equivalent type of treatment which, in the case of inorganic waste treatment, is generally sufficient to prevent damage to water uses. However, in many cases, primary treatment is not adequate to protect watercourses from the effects of organic pollution.

TABLE D
EXISTING INDUSTRIAL WASTE* TREATMENT FACILITIES

Type of Industry	Number of Plants	Number of Industrial Plants Having: Treatment Facilities	No Treatment Facilities	Undetermined Facilities
Food and Kindred Products	19	8	10	1
Paper and Allied Products	4	4	0	0
Chemical and Allied Products	2	2	0	0
Petroleum Products	1	1	0	0
Primary Metals	28	17	2	9
Fabricated Metals	2	1	1	0
Mining	137	57	39	41
Miscellaneous	3	3	0	0
TOTAL	196	93	52	51

*Industries having separate outlets and discharging wastes directly to watercourse.

A study of the adequacy of the existing treatment facilities shows that 39 of the 51 sewage treatment plants have satisfactory capacity to handle the present load, while 11 do not have adequate capacity.

TABLE E
ADEQUACY OF EXISTING TREATMENT FACILITIES

Existing Treatment Facilities	Total Number	Adequacy with Relation to Capacity: Satisfactory	Unsatisfactory	Undetermined	Operation: Satisfactory	Unsatisfactory	Undetermined
Municipal	51	39	11	1	35	7	9
Industrial	93	75	9	9	77	5	11

The majority of the industrial waste plants have adequate capacity to provide a sufficient degree of treatment to protect the downstream water uses. Six of the nine that do not have adequate capacity are plants treating organic wastes at food or paper industries. Practically all of the industries that have provided waste treatment facilities are operating them in a satisfactory manner and are obtaining maximum efficiency out of the available facilities.

The first treatment plants in the basin were constructed at Gilbert, Minnesota, and Iron River, Wisconsin, in 1915. Nine municipalities constructed plants during the 1920's, and five others placed plants into operation between 1930 and 1940. In 1940, five more plants were constructed in the basin, and then there was a lull in construction until 1952 when three municipalities completed plants designed to serve a total of about 12,500 people. Seven municipalities completed plants in 1953 that were designed to treat the wastes from a total population of 45,000.

The largest of these plants served 16,000 and the smallest was designed for 420. One industry constructed a waste treatment plant in 1953.

Practically all of the basin drainage area located in Wisconsin, and in Houghton and Baraga Counties in Michigan is now in organized soil conservation districts. The Soil Conservation Service, working through these districts, provides technical assistance to the farmers in installing conservation practices, such as contour farming, contour and wind strip cropping, terracing, pasture improvement, tree planting and improved rotations. These practices tend to reduce the sediment loads of the streams in the watershed, bringing about a reduction in the damage to fish life, silting of reservoir and stream channels and damage to agricultural lands.

The water pollution control laws of the States are adequate to abate existing pollution and to prevent or control new or increased sources of pollution. The water pollution control agencies have been given sufficient legal authority to carry on their programs and they have used this authority judiciously and effectively in carrying out their work. The following brief analysis presents the salient features of water pollution control legislation of the States in the basin.

The Michigan Water Resources Commission has the general over-all authority relating to the control of pollution of any waters of the State. The Department of Conservation and the State Health Department also have related water pollution control functions.

The Water Resources Commission consists of the Director of Conservation, the Commissioner of Health, the Highway Commissioner, the Director of Agriculture and three other members appointed by the Governor to represent industry, municipalities and conservation interests. The Commission has the power to establish pollution standards for State waters in relation to their public use; to make rules and regulations; to make determinations of existing and possible future pollution and to issue orders to secure correction of such pollution. It has the power to hold hearings and to enforce its regulations and orders; to make surveys, studies and investigations; and to cooperate and negotiate with other governments, governmental units and agencies in matters concerning the water resources of the State.

The Michigan Department of Conservation has the duty to prevent and guard against the pollution of lakes and streams for protection of fish within the State and to enforce all laws provided for that purpose; and the Michigan Department of Health has the authority to make and enforce rules and regulations governing the method of conducting and operating sewerage systems, to review plans and specifications for such systems and to issue permits for their construction. It also has the duty to inspect sewerage systems and if they are found inadequate it may order such alterations as are deemed necessary.

In Minnesota, a comprehensive State water pollution control act was enacted in 1945 with authority vested in a Water Pollution Control Commission. The State Department of Health also has certain water pollution functions relating to public health and sources of water supply for domestic use. The Water Pollution Control Commission is composed of the Secretary and Executive Officer of the State Board of Health, the Commissioner of Conservation, the Commissioner of Agriculture, Dairy and Food, the Secretary and Executive Officer of the State Livestock Sanitary Board and three members at large who shall represent municipal government, industry and general public. The Commission is given the power and duty to make such administrative classifications of the waters of the State as it may deem advisable and establish reasonable pollution standards of the waters of the State in relation to the public use to which they are or may be put. Also, the Commission has the power and duty to approve plans for disposal systems; to issue, continue in effect, or deny, permits for the discharge of wastes or for the installation or operation of disposal systems or parts thereof; and to revoke or modify any permit, when necessary, to prevent or abate pollution of any waters of the State. The Commission is authorized to hold hearings and issue orders, if necessary, to prevent pollution. Although the Commission is a separate and distinct entity, all investigations and other staff functions are performed by the State Department of Health.

In Wisconsin, the primary responsibility for the water pollution control program has been vested in the Committee on Water Pollution. The State Board of Health also has comprehensive water pollution control functions. The 1927 Wisconsin State Legislature created the Committee on Water Pollution and designated its powers and duties. This legislation was called the State Water Pollution Control Act and was last revised in 1949.

The Committee on Water Pollution consists of the State Chief Engineer, and a member or other representative of the Public Service Commission designated by the Commission; a Conservation Commissioner, or an employee designated by the Conservation Commission; the State Health Officer, or a member of the Board of Health designated by the Board; and the State Sanitary Engineer, or other engineer appointed by the State Board of Health.

The Committee on Water Pollution is given the power and duty to exercise general supervision over the administration and enforcement of all laws relating to the pollution of the surface waters of the State. The Committee is authorized to issue general orders and adopt rules and regulations applicable throughout the State, and to issue special orders directing particular owners to secure stated operating results toward control of pollution of surface waters within a specified time, and can obtain enforcement of its orders through court action. The Committee also has the authority to make studies and investigations, as well as conduct scientific experiments and research, and may enter into agreements with other States and with the Federal Government.

The Minnesota Water Pollution Control Commission and the Wisconsin Committee on Water Pollution have in force the following joint resolution relative to the abatement of pollution on the St. Louis River, St. Louis Bay, Superior Bay and Lake Superior:

"WHEREAS, the St. Louis River, St. Louis Bay, Superior Bay and Lake Superior are interstate waters common to the states of Minnesota and Wisconsin and pollution thereof originating in one state does or may adversely affect public water supplies, public health, or public rights in both states, thus creating a problem of common interest, and requiring correction by said states; and

"WHEREAS, sewage and industrial wastes are now discharged into said waters and their tributaries to an extent affecting their cleanliness and purity, causing the same to be injurious to public health, harmful for recreational use, and deleterious to fish and wildlife; and

"WHEREAS, protection of the public health and preservation of public rights demand that said waters and their tributaries shall be made suitable for legitimate uses; therefore be it

"RESOLVED: That the Minnesota Water Pollution Control Commission and Wisconsin Committee on Water Pollution do hereby agree to follow the established programs for the improvement of the quality of said interstate waters and their tributary streams whereby each state shall require the effective prevention or correction of pollution originating within that state as provided by the laws of such state to the end that said waters and their tributaries may be maintained or rendered suitable for appropriate public uses; and be it further

"RESOLVED: That adoption of this resolution by the water pollution control agency of each state shall be evidenced by the signature of its executive officer."

A joint resolution concerning the Montreal River, as well as other streams common to both States, has been adopted by the Michigan Water Resources Commission and the Wisconsin Committee on Water Pollution as follows:

"WHEREAS, the MONTREAL RIVER, the BRULE RIVER and the MENOMINEE RIVER are interstate streams common to the States of Michigan and Wisconsin and pollution thereof, and of their tributaries, originating in one state does or may adversely affect public health or public rights in both states, thus creating a problem of common interest requiring correction by said states; and

"WHEREAS, protection of public health and preservation of public rights require that pollution of said waters by sewage and industrial wastes injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreation or other pursuits, or to wildlife, fish or aquatic life be abated or prevented; now therefore

"BE IT RESOLVED, that the Michigan Water Resources Commission and the Wisconsin Committee on Water Pollution each does hereby agree to require the effective abatement of existing pollution and prevention of additional pollution of said streams and tributaries from

sources within the boundaries of its state as provided by the laws of such state to the end that said waters may be maintained or rendered suitable for the purposes heretofore defined and that in furtherance of these objectives, the guiding policy shall be that facilities for treatment of sewage shall provide at least effective sedimentation and disinfection with such secondary or higher degree of treatment as conditions may require and that facilities for treatment or control of industrial wastes shall provide the degree of protection against pollution warranted in each case; and

"BE IT FURTHER RESOLVED that adoption of this resolution by the water pollution control agency of each state shall be evidenced by the signature of its executive officer."

POLLUTION PREVENTION MEASURES REQUIRED

To obtain the maximum utilization of the water resources of the Lake Superior Drainage Basin, sewage and industrial wastes discharged to the streams and lakes must be treated to insure that water of suitable quality is available for all water uses. In view of the importance of industry and recreation to the economy of the region, the surface waters available for these uses should be maintained at a quality level that will stimulate the greatest development of these uses.

Water quality objectives pertinent to this basin have been discussed in the section of this report entitled "Uses of Water Resources." The type and design of each individual sewage or waste treatment plant depends upon several variable factors that can be determined only after an engineering survey of local conditions. The exact amount and type of wastes discharged are not known for some of the smaller problems in the basin, but preliminary studies and estimations are sufficient to set forth the abatement needs, and a local engineering survey will determine the exact type and degree of treatment needed. To insure that treatment facilities will satisfactorily protect the water uses and to safeguard the taxpayers' investment, the State water pollution control agencies review plans before construction is undertaken.

The degree of treatment required is influenced by the amount of dilution water available during periods of critical low flow and the water uses to be protected. Two separate and distinct critical stream flow periods occur in this region; the first during fall, and the second during winter. Rising water temperatures reduce the capacity of the water to absorb and hold oxygen during low flow periods which occur in hot weather, while, at the same time, the high temperatures accelerate the rate of biological activity with a corresponding increase in the amount of oxygen required. During the winter low flow period, heavy and prolonged ice cover precludes or diminishes reaeration of the water; biological activities, while progressing at a slower rate than in warm weather, must be wholly supported by oxygen contained in the receiving waters prior to the discharge of pollution. Thus, where the quantity of waste discharge is large, as in areas where industry is concentrated or where large cities are located, undesirable water conditions are accentuated during low flow periods. At those points where stream flows may become critical, a high degree of treatment is essential to keep residual pollution loading within the stream's capacity for assimilation during such critical periods.

A number of studies, surveys and investigations have been conducted by Michigan, Minnesota and Wisconsin during recent years and these have provided a sound foundation of facts upon which the pollution abatement program has been based. The collected data have permitted a critical evaluation of the effect of pollution upon the receiving waters and have enabled the States to institute proceedings which will secure protection for water resources of the basin. Construction of these needed facilities at an early date will restore, preserve and protect existing water uses and those uses which may materialize in the immediate foreseeable future. These control measures were determined only after a thorough consideration of all water uses and are considered to be reasonable and adequate. The corrective measures are intended to be flexible and to reflect the needs of the existing situation; however, changes in stream characteristics, pollution load or water uses may require revisions in the indicated treatment needs at some future date.

Considerable progress had been made in providing municipal and industrial waste treatment facilities, but additional plant construction, replacement, and expansion are still needed before all waters of the basin are adequately protected from the effects of municipal and industrial pollution. There is also a need for improved operation at some of the existing treatment plants as failure to operate these waste treatment works at, or near, maximum efficiency means that clean streams for which funds were spent are not obtained.

Pollution prevention measures required to control and abate the damaging effects of pollution in the streams of the basin are described herein. Pollution control programs should be dynamic and flexible as they must change to meet changing conditions. However, the population in most of this basin has been relatively stable for the past 20 years, so it is reasonable to expect that, when the presently needed facilities are completed, the streams of the basin can be maintained in good condition as long as the treatment facilities are maintained and operated properly.

Sixteen municipalities are in need of new sewage treatment plants to serve a total population of 94,000 as shown in Table F, while one community needs to replace its existing plant with

a new one. Plans have been prepared and approved for the plant to serve Superior, Wisconsin, which is the largest city now discharging untreated sewage to the basin's waters. Plans have also been approved for the new sewage treatment plants needed by Ishpeming, Munising and L'Anse, Michigan; Carlton and Floodwood, Minnesota; and Mellen, Wisconsin. Chisholm, Minnesota, is now constructing the plant which it needs to protect its receiving waters. When the above eight plants have been constructed and placed in operation, the number of people discharging untreated sewage to the basin's watercourses will be reduced to less than 10 percent of the basin's total sewered population. Four of the other communities now without sewage treatment facilities are actively planning new plants, leaving less than five percent of the basin's sewage for which treatment does not exist or is not being planned.

TABLE F
REQUIREMENTS FOR MUNICIPAL AND INDUSTRIAL WASTE TREATMENT PLANTS

Requirements	Municipal		Industrial
	Number of Plants	Population Served by Facilities	Plants Needed
New Plant	16	93,790	11
Enlargement or Addition to Existing Plant	9	110,980	11
Replace Plant	1	170	0
Connect to Municipal Sewer	0	---	1
No Project Required	39*	83,605	78
Extent Undetermined	15	24,230	95

*Includes nine for which the population served is undetermined.

Mountain Iron, Minnesota, is constructing the sewage treatment plant which it needs, while Esko and Duluth, Minnesota, are planning to enlarge their plants. It is estimated that the construction of the municipal facilities which are known to be needed will cost about $5,000,000.

The adequate control of industrial waste pollution requires the construction of 11 new treatment plants and the enlargement of or additions to 11 existing plants. The most important needs, from the standpoint of total organic pollution load to be reduced, are the facilities required by the paper mills.

TABLE G
STATUS OF TREATMENT WORKS PROJECTS TO ABATE POLLUTION
January 1, 1954

Status of Project	Number	
	Municipal	Industrial
No Formal Action	2	1
Plans under Preparation	6	6
Final Plans Approved	7	1
Under Construction	3	5*
Status Undetermined	8	11

*Includes one plant which is expanding its facilities although there is no current need for such expansion.

The pollution abatement program is moving ahead in this basin with three sewage and five industrial waste treatment plants under construction and final plans approved for eight others. Six industries and six municipalities are actively engaged in preparing plans for the facilities that are needed to abate pollution caused by their wastes.

Intensification of State water pollution control educational programs is important to long-range planning and good administration by water pollution control agencies. The undesirable effects of pollution, on public health and water conservation, must be presented to the public if its support of water pollution control measures is to be expected. Responsible officials of both municipalities and industries should become acquainted with expected treatment needs so that the needed improvements can be planned for well ahead of the time when these needs become an actuality and before damage to the waters has occurred.

APPENDIX

APPENDIX I

BASIC DATA ON SOURCES OF MUNICIPAL* POLLUTION

LAKE SUPERIOR DRAINAGE BASIN

Name and Location	Population Served by Sewers	P.E. (B.O.D.) Untreated Wastes**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Dischd. to Watercourse	Treatment Needs	Current Status of Municipal Action
				Capy.	Opr.			
LAKE SUPERIOR:								
Grand Marais, Minn.	855		Primary	Sat.	Unsat.		None	
Beaver Bay, Minn.	Undet.		Secondary	Sat.	Sat.		None	
Two Harbors, Minn.	4,040		None	--	--		New plant	Undetermined
Superior, Wis.	35,000	60,000	None	--	--	60,000	New plant	Plans approved
Bayfield, Wis.	1,100		None	--	--		New plant	Active planning
Washburn, Wis.	1,900		None	--	--	4,000	New plant	Active planning
Ashland, Wis.	10,000		Primary	Sat.	Sat.		None	
Calumet, Mich.	1,460		Secondary	Sat.	Sat.		None	
Ahmeek, Mich.	470		None	--	--		Extent undetermined	
Ft. Wilkims, Mich. St. Park	Undet.		Septic tank and tile field	Sat.	Sat.		None	
Baraga, Mich.	1,100		Primary	Sat.	Sat.		None	
Baraga, Mich. St. Park	Undet.		Secondary	Sat.	Sat.		None	
L'Anse, Mich.	2,560		None	--	--		New plant	Plans approved

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.
**Includes industrial wastes discharged into municipal sewerage systems.

APPENDIX I (Contd.)

Name and Location	Population Served by Sewers	P.E. (B.O.D.) Untreated Wastes**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Dischd. to Watercourse	Treatment Needs	Current Status of Municipal Action
				Capy.	Opr.			
LAKE SUPERIOR (Contd.)								
Huron Mount., Mich. Club	Undet.		Secondary	Sat.	Sat.		None	
Big Bay, Mich.	540		None	--	--		Extent undetermined	
Negaunee, Mich.	5,000		Secondary	Sat.	Sat.		None	
Marquette, Mich.	16,900		Primary	Sat.	Sat.		None	
Munising, Mich.	4,400		None	--	--		New plant	Plans approved
Brimley, Mich. St. Park	Undet.		Secondary	Sat.	Sat.		None	
ST. LOUIS RIVER:								
Cloquet, Minn.	6,600		None	--	--		New plant	Active planning
Scanlon, Minn.	420		Secondary	Sat.	Sat.		None	
Carlton, Minn.	630		None	--	--		New plant	Plans approved
Duluth, Minn.	100,000		Primary	Unsat.	Sat.		Enlargement	Active planning
PARTRIDGE RIVER:								
Aurora, Minn.	1,400		Secondary	Sat.	Sat.		None	
Aurora - Forest Hill Sub-division	180		Secondary	Sat.	Sat.		None	
EMBARRASS R., BIWABIK CR:								
Biwabik, Minn.	1,200		Secondary	Sat.	Sat.		None	

APPENDIX I (Contd.)

Name and Location	Population Served by Sewers	P.E. (B.O.D.) Untreated Wastes**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Dischd. to Watercourse	Treatment Needs	Current Status of Municipal Action
				Capy.	Opr.			
McKINLEY CREEK:								
McKinley, Minn.	210		Primary	Unsat.	Undet.		Additions	Undet.
GILBERT CREEK:								
Gilbert, Minn.	2,250		Secondary	Unsat.	Unsat.		Enlargement	Inactive
ELBOW LAKE OUTLET:								
Eveleth, Minn.	6,300		Secondary	Unsat.	Sat.		Enlargement	Inactive
EAST TWO RIVERS:								
Franklin, Minn.	95		Secondary	Sat.	Sat.		None	
Virginia, Minn.	11,000		Secondary	Sat.	Sat.		None	
WEST TWO RIVERS:								
Mountain Iron, Minn.	1,340		Primary	Unsat.	Unsat.		Additions	Under const.
McQUADE RIVER:								
Kinney, Minn.	420		Primary	Unsat.	Undet.		Additions	Undet.
EAST SWAN RIVER:								
Fraser, Minn.	140		Primary	Unsat.	Undet.		Additions	Undet.
Chisholm, Minn.	6,700		None	--	--		New plant	Under const.
Monroe Location, Minn.	400		Primary	Undet.	Undet.		Extent undet.	
HIBBING CREEK:								
Hibbing, Minn.	15,000		Secondary	Sat.	Sat.		None	

APPENDIX I (Contd.)

Name and Location	Population Served by Sewers	P.E. (B.O.D.) Untreated Wastes**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Dischd. to Watercourse	Treatment Needs	Current Status of Municipal Action
				Capy.	Opr.			
BUHL CREEK:								
Buhl, Minn.	1,440		Secondary	Sat.	Unsat.		None	
WEST SWAN RIVER:								
Mahoning Location, Minn.	225		Primary	Sat.	Sat.		None	
Kerr Location, Minn.	200		Primary	Sat.	Sat.		None	
Kelly Lake, Minn.	600		Secondary	Sat.	Sat.		None	
WHITEFACE RIVER:								
Meadowlands, Minn.	120		Primary	Unsat.	Unsat.		Additions	Undet.
FLOODWOOD RIVER:								
Floodwood, Minn.	510		None	--	--		New plant	Plans approved
MIDWAY RIVER:								
Esko, Minn.	200		Secondary	Unsat.	Unsat.		Enlargement	Active planning
MISSION CREEK:								
Nopeming Sant., Minn.	250		Secondary	Sat.	Undet.		None	
IRON RIVER:								
Iron River, Wis.	1,000		Primary	Sat.	Undet.		None	
BAD RIVER:								
Mellen, Wis.	1,400		None	--	--		New plant	Plans approved

APPENDIX I (Contd.)

Name and Location	Population Served by Sewers	P.E. (B.O.D.) Untreated Wastes**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Dischd. to Watercourse	Treatment Needs	Current Status of Municipal Action
				Capy.	Opr.			
ALDER CREEK:								
Iron Belt, Wis.	400		Primary	Sat.	Undet.		None	
Pence, Wis.	150		Primary	Sat.	Sat.		None	
MONTREAL RIVER:								
Hurley, Wis.	3,000		Primary	Sat.	Sat.		None	
Ironwood, Mich.	13,370		None	--	--		New plant	Default of abatement order
Grandview Hospital	170		Secondary	Unsat.	Sat.		Replacement	Under const.
Ironwood Twp., Mich.	250		Primary	Sat.	Sat.		None	
Ironwood Resettlement Project, Mich.	450		Secondary	Sat.	Sat.		None	
Erwin Twp., Mich.	100		Septic tank and tile field	Unsat.	Unsat.		Extent undet.	
WEST BR., MONTREAL R.:								
Montreal, Wis.	1,500		Secondary	Sat.	Sat.		None	
BLACK RIVER:								
Ramsey, Mich.	1,290		None	--	--		Extent undet.	
Wakefield, Mich.	3,590		None	--	--		New plant	Undet.
Bessemer, Mich.	4,100		Secondary	Sat.	Sat.		None	

APPENDIX I (Contd.)

Name and Location	Population Served by Sewers	P.E. (B.O.D.) Untreated Wastes**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Dischd. to Watercourse	Treatment Needs	Current Status of Municipal Action
				Cap.	Opr.			
PRESQUE ISLE RIVER:								
Marenisco, Mich.	860		None	--	--		Extent undet.	
MINERAL RIVER:								
White Pine, Mich.	Undet.		Secondary	Sat.	Sat.		None	
ONTONAGON RIVER:								
Ontonagon, Mich.	2,290		None	--	--		New plant	Active planning
WEST BP., ONTONAGON RIVER:								
Bergland, Mich.	200		None	--	--		New plant	Undet.
SOUTH BR., ONTONAGON RIVER:								
Ewen, Mich.	500		None	--	--		Extent undet.	
ADVENTURE CREEK:								
Lake Gogebic, Mich. St. Park	Undet.		Secondary	Sat.	Sat.		None	
Gogebic Co., Mich. Park	Undet.		Secondary	Sat.	Sat.		None	
PORTAGE SHIP CANAL:								
Houghton, Mich.	3,700		None	--	--		Extent undet.	
Houghton, Mich. - College of Mining & Technology	1,600		None	--	--		Extent undet.	
Hancock, Mich.	5,550		None	--	--		Extent undet.	

APPENDIX I (Contd.)

Name and Location	Population Served by Sewers	P.E. (B.O.D.) Untreated Wastes**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) Dischd. to Watercourse	Treatment Needs	Current Status of Industrial Action
				Capy.	Opr.			
ADVENTURE CREEK (Contd.)								
Adams Township Houghton Co. Infirmary	Undet.		Secondary	Sat.	Sat.		None	
PORTAGE LAKE, PILGRIM RIVER:								
Painsdale, Mich.	2,000		None	--	--		Extent undet.	
Trimountain, Mich.	830		None	--	--		Extent undet.	
South Range, Mich.	920		Primary	Sat.	Undet.		None	
TORCH LAKE:								
Lake Linden, Mich.	1,630		None	--	--		Extent undet.	
Hubbell, Mich.	2,000		None	--	--		Extent undet.	
TRAP ROCK RIVER:								
Copper City, Mich.	480		Primary	Sat.	Undet.		None	
Laurium, Mich.	3,930		Primary	Sat.	Sat.		None	
CARP RIVER:								
Ishpeming, Mich.	9,500		None	--	--		New plant	Plans approved
Marquette, Mich. Morgan Hts. TB Sanitarium	100		Secondary	Sat.	Sat.		None	
TAHQUAMENON RIVER:								
Newberry, Mich.	2,730		None	--	--		Extent undet.	

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APPENDIX II

BASIC DATA ON SOURCES OF INDUSTRIAL* POLLUTION

LAKE SUPERIOR DRAINAGE BASIN

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
LAKE SUPERIOR								
Superior, Wis.								
Great Northern RR Albany Yard	Misc.	Org. & Inorg.	Primary	Sat.	Sat.		None	
Great Northern RR Superior Yard	Misc.	Org. & Inorg.	Primary	Sat.	Sat.		None	
LakeHead Pipeline Co.	Misc.	Org. & Inorg.	Primary	Sat.	Sat.		None	
Cornucopia, Wis.								
Cornucopia Cheese Fct.	Food	Organic	None	--	--	250	New plant	Undet.
Bayfield, Wis.								
Bayfield Fruit Cannery	Food	Organic	Secondary	Unsat.	Sat.	700 (20 days per year)	Connect to municipal sewer	Undet.
Washburn, Wis.								
Chequamegon Cry. Coop.	Food	Organic	Undet.			500	Extent Undet.	
Barksdale, Wis.								
DuPont Munitions	Chemical	Org. & Inorg.	Primary	Sat.	Sat.		None	
Benoit, Wis.								
Benoit Coop. Cry.	Food	Organic	None	--	--	200	New plant	Undet.
Ashland, Wis.								
Marathon Paper Co.	Paper	Org. & Inorg.	Fibre Recovery	Sat.	Sat.	2,100	None	

*Industries having separate outlets and discharging wastes directly to the watercourses.

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
LAKE SUPERIOR (contd.)								
Calumet, Mich Calumet-Hecla Inc.	Pri Metal	Inorganic	Primary	Sat.	Sat.		None	
Marquette, Mich. Cliffs Dow Co.	Chemical	Org & Inorg.	Primary	Undet.	Undet.		Extent undet.	(Part of wastes to municipal sewer)
Munising, Mich. Munising Paper Co.	Paper	Org. & Inorg.	Primary	Unsat.	Unsat.	31,900	Additions	Active planning
SAINT LOUIS RIVER								
Fayal Twp., Minn. Burns Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Cloquet, Minn. Northwest Paper Co.	Paper	Org. & Inorg.	Primary	Unsat.	Sat.	393,000	Enlargement	Active planning
Wood Conversion Co.	Paper	Org. & Inorg.	Primary	Unsat.	Sat.	161,000	Enlargement	Active planning
Duluth, Minn. Am. Steel & Wire Co.	Pri. Metal	Inorganic	None	--	--		New plant	Plans approved
Barnes-Duluth Shipyards	Fab. Metal	Inorganic	None	--	--		Extent undet.	
Interlake Iron Corp.	Pri. Metal	Inorganic	None	--	--		New plant	Inactive
SILVER CREEK								
Wrenshall, Minn. International Refineries	Petroleum	Org. & Inorg.	Primary	Unsat.	Unsat.		Additions	Under const.

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
PARTRIDGE RIVER								
Mesaba Twp., Minn.								
Graham Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Knox Mine	Mining	Inorganic	Primary	Unsat.	Sat.		Enlargement	Active planning
Wentworth Concent. Pt.	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
Wentworth No. 1 Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Wentworth No. 2 Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Aurora, Minn.								
Erie Preliminary Taconite Plant	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
St. James Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
EMBARRASS RIVER								
White Twp., Minn.								
Pacific Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	Under const.
Biwabik Twp., Minn.								
Emmett Mine	Mining	Inorganic	Undet.				Extent undet.	
BIWABIK CREEK								
Biwabik, Minn.								
Biwabik Concent. Plant	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
Biwabik (Cass) Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Biwabik Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status Of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
BIWABIK CREEK (Contd.)								
Biwabik, Minn. (Contd.)								
Biwabik (Williams) Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Canton Mine	Mining	Inorganic	Primary	Undet.	Undet.		Additions	Under const.
Embarrass Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Hector Mine	Mining	Inorganic	Primary	Undet.	Undet.		Extent undet.	
Higgins No. 1 Mine	Mining	Inorganic	Primary	Undet.	Undet.		Additions	Under const.
Mary Ellen Mine	Mining	Inorganic	Primary	Unsat.	Unsat.		Additions	Active planning
Mary Ellen Concent. Pt.	Pri. Metal	Inorganic	Primary	Unsat.	Unsat.		Additions	Active planning
Ruddy Mine	Mining	Inorganic	Primary	Undet.	Undet.		Additions	Under const.
McKINLEY CREEK								
McKinley, Minn.								
Corsica Mine	Mining	Inorganic	Undet.				Extent undet.	
Corsica Concent. Pt.	Pri. Metal	Inorganic	Undet.				Extent undet.	
GILBERT CREEK								
Gilbert, Minn.								
Genoa-Sparta Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Gilbert Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Pettit Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Schley Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
GILBERT CREEK (Contd.)								
Gilbert, Minn. (Contd.)								
Schley Concent. Plant	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
ELBOW LAKE OUTLET								
Eveleth, Minn.								
Coons-Pacific Concent. Pt.	Pri. Metal	Inorganic	Primary	Sat.	Undet.		None	
Fayal Mine	Mining	Inorganic	Undet.				Extent undet.	
Genoa-Sparta Concent. Pt.	Pri. Metal	Inorganic	Undet.				Extent undet.	
Hull-Nelson Mine	Mining	Inorganic	Undet.				Extent undet.	
Spruce Mine	Mining	Inorganic	Undet.				Extent undet.	
Troy Mine	Mining	Inorganic	None	--	--		Extent undet.	
Virginia Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Virginia Concent. Pt.	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
Leonidas, Minn.								
Leonidas Mine	Mining	Inorganic	None	--	--		None	
EAST TWO RIVERS								
Franklin, Minn.								
Commodore Mine	Mining	Inorganic	Undet.				Extent undet.	
Julia Mine	Mining	Inorganic	Undet.				Extent undet.	
Lone Jack Mine	Mining	Inorganic	None	--	--		Extent undet.	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
EAST TWO RIVERS (Contd.)								
Franklin, Minn. (Contd.)								
Missabi Mtn. Mine	Mining	Inorganic	Undet.				Extent undet.	
Moose Mine	Mining	Inorganic	None	--	--		Extent undet.	
Norman Mine	Mining	Inorganic	Undet.				Extent undet.	
Ohio Mine	Mining	Inorganic	None	--	--		Extent undet.	
Shaw Mine	Mining	Inorganic	None	--	--		Extent undet.	
Yawkey Mine	Mining	Inorganic	Undet.				Extent undet.	
Virginia, Minn.								
Auburn Mine	Mining	Inorganic	None	--	--		Extent undet.	
Charleston Concent. Pt.	Pri. Metal	Inorganic	Undet.				Extent undet.	
Columbia Mine	Mining	Inorganic	Undet.				Extent undet.	
Columbia Concent. Pt.	Pri. Metal	Inorganic	Undet.				Extent undet.	
Enterprise Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Extaca Taconite Pt.	Pri. Metal	Inorganic	Undet.				Extent undet.	
Great Northern Mine	Mining	Inorganic	None	--	--		Extent undet.	
Julia Concent. Plant	Pri. Metal	Inorganic	Undet.				Extent undet.	
Minnewas Mine	Mining	Inorganic	Undet.				Extent undet.	
Prindle Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
EAST TWO RIVERS (Contd.)								
Virginia, Minn. (Contd.)								
Prindle Concent. Plant	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
Rouchleu Mine	Mining	Inorganic	None	--	--		None	
Wuori Twp., Minn.								
Ernie Mine	Mining	Inorganic	None	--	--		None	
Sidney Mine	Mining	Inorganic	Undet.				Extent undet.	
Mountain Iron, Minn.								
Hanna Mine	Mining	Inorganic	Undet.				Extent undet.	
Mott Mine	Mining	Inorganic	Undet.				Extent undet.	
Mountain Iron Concent. Pt.	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
Mountain Iron Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Pilot Mine	Mining	Inorganic	Undet.				Extent undet.	
Pilot Annex Mine	Mining	Inorganic	Undet.				Extent undet.	
Pilotac Taconite Pt.	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
Pilotac Mine	Mining	Inorganic	None	--	--		None	
Snively Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Wacootah Mine	Mining	Inorganic	None	--	--		Extent undet.	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
McQUADE RIVER								
Kinney, Minn.								
Atkins Mine	Mining	Inorganic	Undet.				Extent undet.	
Dormar Mine	Mining	Inorganic	Undet.				Extent undet.	
Forsyth Mine	Mining	Inorganic	Undet.				Extent undet.	
Midway Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Seville Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Wade Mine	Mining	Inorganic	Undet.				Extent undet.	
EAST SWAN RIVER								
Balkan Twp., Minn.								
Forester Mine	Mining	Inorganic	Undet.				Extent undet.	
Fraser, Minn.								
Croxton Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Douglas Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Duncan Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Dunwoody Mine	Mining	Inorganic	Undet.				Extent undet.	
Elbern Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Fraser Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Hartley Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Hartley-Burt Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
EAST SWAN RIVER (Contd.)								
Fraser, Minn. (Contd.)								
Sherman Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Chisholm, Minn.								
Alworth Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Duncan Concent. Pt.	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
Glen Mine	Mining	Inorganic	Undet.				Extent undet.	
Godfrey Mine	Mining	Inorganic	Undet.				Extent undet.	
Humphrey Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Leonard Mine	Mining	Inorganic	Undet.				Extent undet.	
Leonard-Burt Mine	Mining	Inorganic	Undet.				Extent undet.	
Monroe-Tenner Mine	Mining	Inorganic	Undet.				Extent undet.	
Pillsbury Mine	Mining	Inorganic	Undet.				Extent undet.	
St. Clair Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Shenango Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
HIBBING CREEK								
Hibbing, Minn.								
Agnew Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Agnew No. 2 Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Albany Mine	Mining	Inorganic	Undet.				Extent undet.	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
HIBBING CREEK (Contd.)								
Hibbing, Minn. (Contd.)								
Albany Concent. Pt.	Pri. Metal	Inorganic	Undet.				Extent undet.	
Boeing Mine	Mining	Inorganic	None	--	--		None	
Day Mine	Mining	Inorganic	None	--	--		Extent undet.	
Hull-Rust (Hull) Mine	Mining	Inorganic	None	--	--		Extent undet.	
Hull-Rust (Rust) Mine	Mining	Inorganic	None	--	--		Extent undet.	
Hull-Rust Concent. Pt.	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
Impro A Mine	Mining	Inorganic	None	--	--		Extent undet.	
Longyear Mine	Mining	Inorganic	Undet.				Extent undet.	
Longyear Concent. Pt.	Pri. Metal	Inorganic	Undet.				Extent undet.	
Mahoning Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Morris Mine	Mining	Inorganic	Undet.				Extent undet.	
Penobscott Mine	Mining	Inorganic	None	--	--		Extent undet.	
Scranton Mine	Mining	Inorganic	None	--	--		Extent undet.	
Scranton Concent. Pt.	Pri. Metal	Inorganic	Primary	Sat.	Unsat.		Extent undet.	
Sellers Mine	Mining	Inorganic	None	--	--		Extent undet.	
Sellers Triangle Mine	Mining	Inorganic	Undet.				Extent undet.	
South Agnew Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	

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APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
HIBBING CREEK (Contd.)								
Hibbing, Minn. (Contd.)								
So. Agnew Concent. Pt.	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
South Longyear Mine	Mining	Inorganic	Undet.				Extent undet.	
South Rust Mine	Mining	Inorganic	None	--	--		Extent undet.	
Susquehanna Mine	Mining	Inorganic	None	--	--		Extent undet.	
UNO Concent. Plant	Pri. Metal	Inorganic	Primary	Undet.	Undet.		Extent undet.	
Webb Mine	Mining	Inorganic	Undet.				Extent undet.	
Webb Concent. Plant	Pri. Metal	Inorganic	Undet.				Extent undet.	
Weggum Mine	Mining	Inorganic	None	--	--		None	
Weggum Concent. Plant	Pri. Metal	Inorganic	Primary	Sat.	Sat.		None	
BUHL CREEK								
Great Scott Twp., Minn.								
Judson Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Margaret Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
North Shirus Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Wheeless Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Whiteside Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Woodbridge Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged Wat to Watercourse	Pollution Abatement Needs	Current Status of Municipal Action
			Degree	Adequacy				
				Capy.	Opr.			
WEST SWAN RIVER								
Stuntz Twp., Minn.								
Carmi Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Cyprus Mine	Mining	Inorganic	Undet.				Extent undet.	
Kerr Mine	Mining	Inorganic	Undet.				Extent undet.	
Mahoning Group 3 Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Mahoning Group 4 Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Mahoning Group 6 Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Midget Mine	Mining	Inorganic	Undet.				Extent undet.	
South Eddy Mine	Mining	Inorganic	Undet.				Extent undet.	
Kelly Lake, Minn.								
Great Northern RR Co.	Fab. Metals	Org. & Inorg.	Primary	Sat.	Sat.		None	
Lamberton Mine	Mining	Inorganic	Undet.				Extent undet.	
Morton Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
Nordine Mine	Mining	Inorganic	Undet.				Extent undet.	
FLOODWOOD RIVER								
Floodwood, Minn.								
Floodwood Coop. Cry. Assn.	Food	Organic	None	--	--		New plant	Undet.

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
POPLAR RIVER								
Poplar, Wis.								
Poplar Canning Co.	Food	Organic	Primary	Unsat.	Undet.		Additions	Undet.
IRON RIVER								
Iron River, Wis.								
Fuhrman Cheese Fct.	Food	Organic	None	--	--	200	New plant	Undet.
Fuhrman Sausage Fct.	Food	Organic	None	--	--	100	New plant	Undet.
FISH RIVER								
Moquah, Wis.								
Moquah Cheese Factory	Food	Organic	None	--	--	200	New plant	Undet.
WHITE RIVER								
Mason, Wis.								
Mason Milk Products	Food	Organic	None	--	--		New plant	Undet.
MARENGO RIVER								
Marengo, Wis.								
Marengo Coop Dairy Assn.	Food	Organic	None	--	--		New plant	Undet.
BAD RIVER								
Saxon, Wis.								
Belmonte Cheese Factory	Food	Organic	None	--	--	200	New plant	Undet.
MONTREAL RIVER								
Ironwood, Mich.								
Pabst-Aurora Mines	Mining	Inorganic	None	--	--		Extent undet.	

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			Degree	Adequacy				
				Capy.	Opr.			
BLACK RIVER								
Ironwood, Mich.								
Oliver Iron Mining Co. Davis-Geneva Mines	Mining	Inorganic	Primary	Sat.	Sat.		None	
Youngstown Mines Corp. Newport-Bonnie Mines	Mining	Inorganic	Primary	Sat.	Sat.		None	
Wakefield, Mich.								
Plymouth Mine	Mining	Inorganic	None	--	--		Extent undet.	
Ramsey, Mich.								
Palms-Anvil Mine	Mining	Inorganic	None	--	--		Extent undet.	
Eureka Mine	Mining	Inorganic	None	--	--		Extent undet.	
Bessemer, Mich.								
Bessemer Cry.	Food	Organic	Primary	Undet.	Undet.		Extent undet.	
Sunday Lake Mine	Mining	Inorganic	None	--	--		Extent undet.	
Vicar Mine	Mining	Inorganic	None	--	--		Extent undet.	
MINERAL RIVER								
White Pine Mine, Mich.								
White Pine Mine	Mining	Inorganic	Primary	Sat.	Sat.		None	
MIDDLE BRANCH, ONTONAGON R.								
Bruce Crossing, Mich.								
Ontonagon Valley Cry.	Food	Organic	Primary	Sat.	Sat.		Extent undet.	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
SOUTH BRANCH, ONTONAGON R.								
Ewen, Mich.								
Ewen Farmers Coop. Cry.	Food	Organic	Primary	Undet.	Undet.	2,400	Extent undet.	
PORTAGE SHIP CANAL								
Dollar Bay, Mich.								
Copper Country Cheese Co.	Food	Organic	Primary	Sat.	Sat.		Extent undet.	
Houghton, Mich.								
Bosch Brewing Co.	Food	Organic	None	--	--		Extent undet.	
GRATIOT RIVER								
Ahmeek, Mich.								
Ahmeek-Seneca Copper Mines	Mining	Inorganic	None	--	--		Extent undet.	
EAGLE RIVER								
Phoenix, Mich.								
Central Copper Mine	Mining	Inorganic	None	--	--		Extent undet.	
STURGEON RIVER								
Covington, Mich.								
Watton-Covington Cry.	Food	Organic	Whey disposed to waste land	Sat.	Sat.		None	
Pelkie, Mich.								
Pelkie Cheese Co.	Food	Organic	Whey disposed to farmers	Undet.	Undet.		Extent undet.	

APPENDIX II (Contd.)

Name and Location	Type of Industry	Type of Waste Produced	Treatment or Other Pollution Control Measures			P.E. (B.O.D.) Discharged to Watercourse	Pollution Abatement Needs	Current Status of Industrial Action
			Degree	Adequacy				
				Capy.	Opr.			
CARP RIVER								
Snowville, Mich.								
Blueberry Mine	Mining	Inorganic	None	--	--		Extent undet.	
Greenwood, Mich.								
Greenwood Mines	Mining	Inorganic	None	--	--		Extent undet.	
Ishpeming, Mich.								
Cliff Shaft Mine	Mining	Inorganic	None	--	--		Extent undet.	
Lloyd-East Lloyd Mines	Mining	Inorganic	None	--	--		Extent undet.	
Mather Mine	Mining	Inorganic	None	--	--		Extent undet.	
Morris Mine	Mining	Inorganic	None	--	--		Extent undet.	
Negaunee, Mich.								
Mass-Race Course Mines	Mining	Inorganic	None	--	--		Extent undet.	
Negaunee Mine	Mining	Inorganic	None	--	--		Extent undet.	

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